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Geoscientific Model Development Discussions

Interactive comment on "SALSA2.0: The sectional aerosol module of the aerosol-chemistry-climate model ECHAM6.3.0-HAM2.3-MOZ1.0" *by* Harri Kokkola et al.

Anonymous Referee #1

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In this study an updated version of the SALSA sectional aerosol module in the ECHAM-HAMMOZ is described. In an extensive comparison the model results are compared to MODIS satellite retrievals, AERONET measurements, measurements from the IMPROVE and EMEP network, multiple aircraft campaigns and size distribution measurements at EUSAAR sites. Performance is compared to the HAM default aerosol scheme M7. Simulations of the Pinatubo are added to demonstrate the performance of SALSA2.0 in atypical aerosol regimes. The validation against measurements is very comprehensive and addresses many different aspects of the aerosol distribution. However, by limiting the comparison of the performance of SALSA2 to M7 it is difficult to judge if SALSA2.0 is a real improvement to SALSA1 or to judge how SALSA2.0

performs compared with other sectional aerosol modules which have a fundamentally different approach and substantially increase computational costs. Although the following points might involve a lot of work, addressing these would greatly improve the quality of this work.

1 General comments

1. Performance of SALSA2.0 is compared to the ECHAM-HAMMOZ default (modal) aerosol module M7. Consequently, many of the differences in this work are attributed to the difference in the numerical treatment of the aerosol size distribution in modal or sectional schemes. Because of this, the manuscript does not really give an indication of how well SALSA2.0 performs compared to other sectional modules.

2. The paper describes the difference between SALSA1 and SALSA2.0 well, but does not discuss the reasons why certain changes are made to the SALSA module. Please explain what the main problems with SALSA1 are and how these changes contribute to the improvement of the aerosol module.

3. Previous work (also referred to in this article) has shown that modal aerosol representations do not perform well in simulating stratospheric aerosol caused by volcanic eruptions and that sectional approaches yield far better results. It is therefor not surprising that SALSA2.0 performs better than M7, but how does it compare to e.g. SALSA1? Overall, the discussion of the Pinatubo simulation is thin and mainly addresses issues in M7. As it is now, it might be better to remove this section from the paper as the remainder is already a very comprehensive comparison to observations.

4. The authors state that a size-resolved wet deposition scheme for SALSA2.0 is still

under development. To make a fair comparison to M7 an older removal scheme is also used for those simulations. In my opinion, the quality of this paper would greatly improve if the new wet deposition scheme is included in this work. In the comparison to aircraft measurements in the results section it is also explicitly mentioned how the new wet deposition scheme would improve the results of the simulations with SALSA2.0.

2 Specific comments

Title / Page 8, line 9-13 Judging from the text, the MOZ module is not used in this work and HAMMOZ is reduced to HAM only. This is a bit misleading and causes confusion in the text. It is not clear what value the combination of HAM and MOZ has in this work. It should be clarified better what MOZ does in the model simulations for this work, otherwise it might be better to remove MOZ from the title.

Page 2, line 31 100 size classes is a bit of an exaggeration, in global models the number of size classes is usually (much) lower.

Page 5, line 21-23 Two subranges of SALSA1 are combined into one in SALSA2.0, what is the reason for this simplification and what are expected changes in the simulated aerosol size distribution?

Page 5, line 25-26 The moving center method is replaced by the hybrid bin method. What are the downsides to this method as is was not used in SALSA1 before?

Page 7, line 8-9 In view of the importance of meteorology for e.g. dust emissions, what is the nudging time interval used in the simulations?

Page 8, line 14-34 The different parameterisations of SALSA2.0 and M7 are explained extensively in Section 2.3, but several of these are changed for the simulations. This is very confusing and makes large parts of previous section irrelevant. It would be better to describe what is actually used. Also, this means that this work presents results from a suboptimal model run and the full potential of the SALSA2.0 module in the ECHAM-HAMMOZ model is not shown.

Page 9, line 26 How is this ensemble constructed? What is the difference between the 5 members?

Page 13, line 6 Judging from this work, the implementation of the new Long et al. (2012) sea salt emission decreases the model performance, why was it introduced?

Page 15, line 4 Here, the low AOD bias is (almost) completely attributed to the low SS emissions. Although this assumption is acceptable for the SH, there is also a strong bias in the NH high latitudes. Here, the low bias over the land masses cannot be attributed to sea salt only.

Page 15, line 13-14 How did you arrive to this conclusion?

Page 15, line 25 Why is this not mentioned in Section 4.1.1?

Section 4.2 Restructure section. Multiple species of multiple model runs are compared to multiple measurement networks, This already makes the discussion hard to read. I suggest a fixed format/structure in discussing the different species to help the reader.

Page 18, line 1-22 Include comparison results of M7 in discussion of SU/BC.

Page 19, line 9 Aerosol load over oceans is not low over SH subtropics.

Page 19, line 15 If periods in observations and simulations are different, how are they collocated?

Page 22, line 20 Why are monthly mean model values used here? Having 3 hourly output, collocation can be greatly improved. Also, comparison for SU and OA is based on daily mean output. What is the reason for this inconsistent approach?

Page 25, line 5-6 This conclusion is too strong and drawn too quickly. It would be the case for the ARCTAS Spring and ARCPAC campaigns, but for the ARCTAS Summer, the wet deposition scheme barely influences the results for the lower part of the atmosphere where observations are available. Also, for the source regions, an increase due to the wet deposition scheme, would increase the already high bias in SALSA.

Page 26, line 1 "Difference was fairly small". Can this statement be quantified?

Section 6 In this section, it is explained why the section approach of M7 does not perform well in simulation the stratospheric aerosol burden resulting from a volcanic eruption. There is even a reference to a solution for this problem. Yet you don't incorporate this in your model and compare the performance of SALSA2.0 mainly to the simulation with the unadjusted M7 scheme. As a result, it is difficult to really judge how well SALSA2.0 performs in these simulations. It would be more interesting to see the performance of SALSA2.0 to other sectional aerosol modules or modal schemes that were properly adjusted.

Page 26, line 1-2 How are the model values and observations collocated?

Section 7. Conclusions The structure of the conclusion section is unnecessarily confusing. Follow same order as discussion in Results section.

Page 29, line 6 What are recommendations for optimizing?

Page 30, line 1-2 Underestimation of particle number in SALSA1 not mentioned in Section 4.1.1.

3 Technical comments

Page 4, line 12 Sentence is not clear, please rephrase.

Page 5, line 13 "using the volume ratio" → "using volume ratio"

Page 7, line 10 Add full name of PCMDI

Page 10, line 21-23 Why is India omitted from this list?

Page 11, Figure 2 Add statistics (e.g. corresponding global mean AOD to a,b,c and correlation coefficients and NMBs to d,e) to the figure for a good overview between model configurations.

Page 12, line 2 Equation straightforward, can be removed and explained in words.

Page 13, line 1 Fig 4. → Fig. 5

Page 14, line 12 Reference to current section.

Page 15, line 17 Add minus sign to 0.05.

Page 16, Figure 6 Change colours of Asia and North America. These are the two regions discussed in the text but hardly distinguishable from each other. Also, adding a regional mean values would provide a good overview of model performance.

Page 17, Figure 7 Remove additional abbreviations of species in lower left corner of each panel. Add names of network to panels.

Page 20, Figure 9 Observed and simulated values in year 2010? Please add to caption.

Page 22, line 32 Vertical profiles of AMMA, ARCTAS Spring and OP3 are not captured well either.

Page 26, line 1-2 Add references for the HIRS and lidar observations.

Page 29, Fig. 14 Add errorbars to observed values.

Page 30, line 23 confiburations → configurations